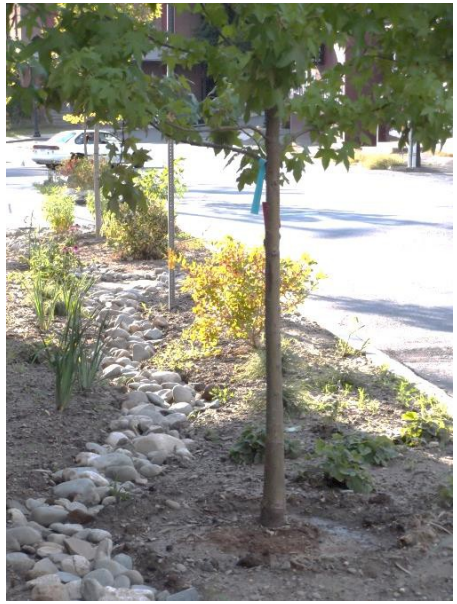
CITY OF GREENFIELD

Low Impact Development:

A Developer's Guide to Innovative Stormwater Management Techniques



Examples of LID Stormwater Management Techniques

VEGETATED SWALES AND FILTER STRIPS

Vegetated swales and filter strips work together to filter out pollutants and treat and store runoff. Swales are vegetated open channels that collect runoff from adjacent roadways or parking lots and store and treat it. Swales can be used in subdivisions, parking lots, and commercial and industrial development. Swales work best when combined with a filter strip, which consists of grass or close-growing vegetation that intercepts runoff from surfaces, slowing it down and filtering out sediment and other pollutants.

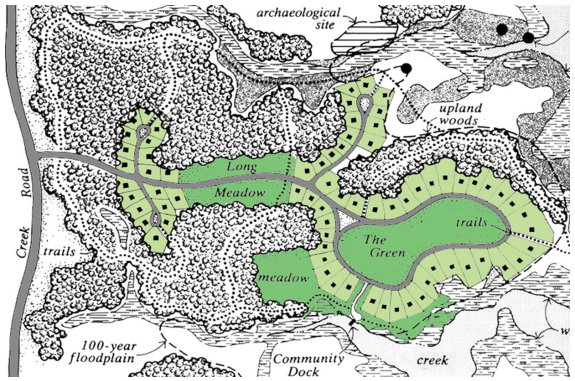
Greenfield's Subdivision Regulations encourage the use of roadside swales and other LID techniques.

Below graphic credit: MassDOT Separated Bike Lane Planning and Design Guide

SITE PLANNING

Low Impact Development site planning seeks to minimize the amount of stormwater runoff from the development in the first place. Basic principles include building on previously disturbed sites, reducing impervious surface area (design narrower, shorter roads and driveways, avoid excessive parking, use permeable pavement/porous asphalt, etc.), minimizing tree clearing and grading, and maintaining the natural topography of the site by minimizing cut and fill. New subdivisions should site homes in the least environmentally sensitive areas.

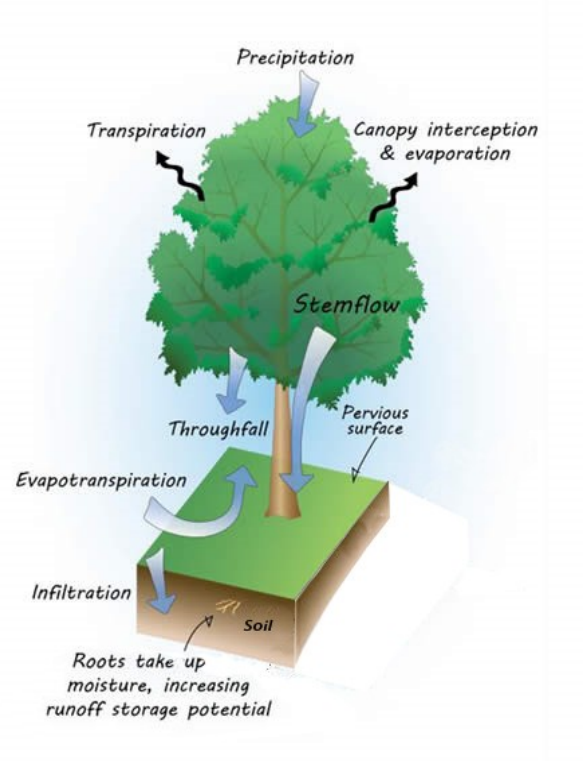
Greenfield's Subdivision Regulations call for narrower roads that conform to the existing contours of the land. Clustering homes in the Rural Residential district is encouraged, where flexible lot sizes are allowed in exchange for protected open space.



Examples of LID Stormwater Management Techniques

TREES

Trees in the built landscape offer many environmental and quality of life benefits. Trees intercept rain on leaves and branches, delaying and reducing peak flows. They absorb groundwater through roots, increasing runoff storage capacity. Trees shade pavement and buildings, reducing the urban heat island effect and the costs and energy associated with cooling buildings. Trees provide numerous other quality of life benefits, including cleaner air, traffic calming, noise reduction, and increased



Greenfield's Subdivision Regulations, Zoning Ordinance, and Tree Ordinance seek to minimize the removal of mature trees during development or redevelopment projects.

Graphic credit: *Stormwater to Street Trees: Engineering Urban Forests for Stormwater Management*. U.S. EPA, 2013

Greenfield's parking regulations require a shade tree for every ten (10) parking spaces, to be distributed throughout the parking lot for maximum shading. The regulations also require shade trees to be planted within the perimeter landscaped buffer between the public right of way and the parking area.

The value of street trees goes beyond simple aesthetics. In addition to benefits already mentioned, neighborhoods with mature street trees are attractive places to walk, bike, and be outside, improving public health and helping to build a sense of community. Greenfield's Subdivision Regulations encourage street trees to be planted in the tree belt.

Developer's Guide to Low Impact Development, City of Greenfield, MA

Examples of LID Stormwater Management Techniques

BIORETENTION / RAIN GARDENS

Bioretention / rain gardens are planted areas that collect, clean, cool, and infiltrate stormwater and direct water to trees or other desired plantings for birds and pollinators from roads, parking lots, driveways, sidewalks, and roofs. Native plants and trees tolerant of drought and intermittent wet conditions, and occasional salt from paved surfaces, should be used. In slowly permeable soils a perforated underdrain may be installed at the bottom of the excavation to prevent ponding. Routine maintenance can be handled by homeowners or landscaping companies with proper direction.

Greenfield's Subdivision Regulations encourage the use of LID stormwater features in new Subdivisions.

A bioretention area located in the tree belt can collect stormwater runoff from the sidewalk and street.

Cul-de-sac islands offer an opportunity for collecting and infiltrating stormwater. Greenfield's Subdivision Regulations require a landscaped island for all cul-de-sacs.

Greenfield's Zoning Ordinance encourages bioretention for parking lot medians and islands.

Examples of LID Stormwater Management Techniques

PERMEABLE PAVEMENT / POROUS ASPHALT / GRASS PAVERS

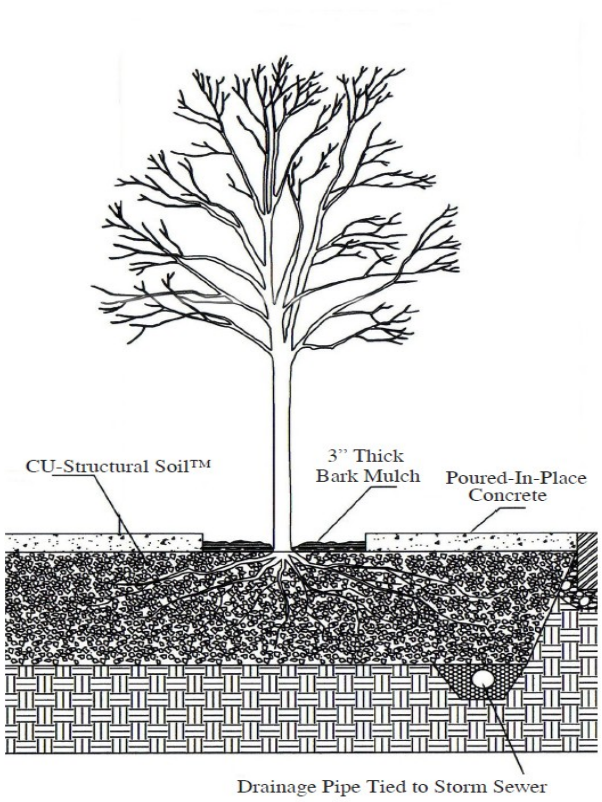
Permeable pavement / porous asphalt / grass pavers allow water to filter through, recharging groundwater and reducing the amount of runoff on a site. Permeable pavement or porous asphalt is appropriate for low traffic areas such as parking stalls, overflow parking areas, sidewalks and walkways, and residential driveways. Maintenance varies depending on the type of pavement, and may include periodic vacuum sweeping, reseeding of grass pavers, or refilling joint material.

Greenfield's Zoning Ordinance encourages the use of porous asphalt for parking stalls and overflow parking areas when feasible.

Paving stones, grass pavers, and the use of a "two-track" design are allowed for residential driveways.

STRUCTURAL SOILS

Structural soil is a mix of gravel and clay loam soil. The gravel provides load bearing support for pavement while also providing roughly 20% - 25% void space, which supports tree growth and stormwater infiltration. Structural soils can work well in tree belts and parking lot islands, extended out for 5-10 feet from these points under impervious in parking lots, sidewalks, and plazas, and are particularly effective when combined with permeable pavement or porous asphalt.



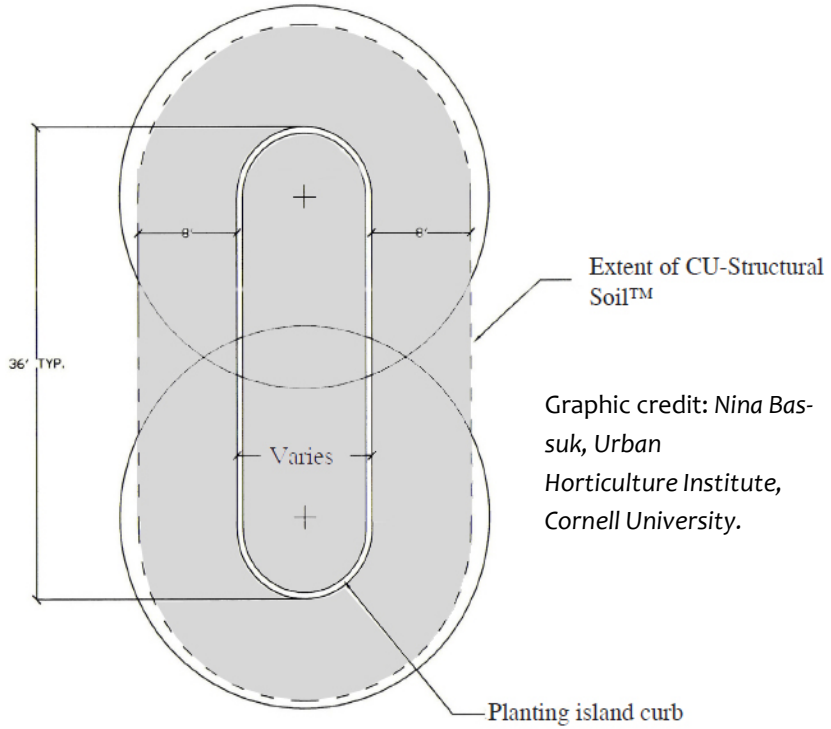
Greenfield's parking regulations encourage the use of structural soils in parking lots.

Graphic credit: Nina Bassuk, Urban Horticulture Institute, Cornell University.

Examples of LID Stormwater Management Techniques

URBAN TREES AND THE USE OF STRUCTURAL SOIL

Urban trees experience a litany of environmental insults: soil and air pollution, heat loads, deicing salts, and impacts from utilities, vehicles, and buildings. The most significant problem that urban trees face, however, is the lack of oxygen for their roots, which is caused by a lack of tree root space, soil compaction, and poor drainage. Dense soil can also cause superficial rooting systems that cause pavement heaving and makes the tree more vulnerable to drought.



Graphic credit: *Nina Bassuk, Urban Horticulture Institute, Cornell University.*

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ABOUT STRUCTURAL SOIL & HOW TO USE IT

Healthy trees need a large volume of non-compacted soil with adequate drainage and aeration and reasonable fertility. Structural soil meets engineers' load-bearing requirements for base courses under pavement, and enables healthy root growth. It is a mixture of load-bearing stone and soil. Uniformly graded 3/4"-1 1/2" angular crushed stone ensures the greatest porosity. Soil with a minimum of 20% clay and 2-5% carbon content is recommended. It should be used to a depth of 24-36".

Resources

City of Greenfield Department of Planning and Development: http://greenfield-ma.gov/p/29/Department-of-Planning--Development Find the most recent Zoning Ordinance, Subdivision Regulations, and City planning documents.

General Information:

Franklin Regional Council of Governments (FRCOG) Green Infrastructure webpage: http://frcog.org/program-services/natural-resources-planning/green-infrastructure-and-low-impact-development/ Includes information on projects and initiatives in Franklin County.

United States Environmental Protection Agency (EPA) Green Infrastructure website: http://water.epa.gov/infrastructure/greeninfrastructure/

Massachusetts Smart Growth / Smart Energy Toolkit: http://www.mass.gov/envir/smart_growth_toolkit/pages/mod-lid.html

Design Guides and Specifications:

Massachusetts Stormwater Handbook: http://www.mass.gov/eea/agencies/massdep/water/regulations/massachusetts-stormwater-handbook.html See Volume 2, Chapter 2: Stormwater Best Management Practices for design specifications.

Massachusetts Clean Water Toolkit: http://prj.geosyntec.com/npsmanual/default.aspx Also known as the *Massachusetts Nonpoint Source Pollution Management Manual*, the Toolkit is an interactive tool that includes information about nonpoint source pollution, a selector tool for choosing appropriate best management practices by criteria, and BMP factsheets.

Massachusetts Watershed Coalition, Community Guide to Growing Greener: http://commonwaters.org/resources/community-guide-to-growing-greener Describes design and construction practices for stormwater management, erosion and sedimentation control, landscape design, and site planning.

University of New Hampshire (UNH) Stormwater Center: http://www.unh.edu/unhsc/. Includes information on research of stormwater technologies, design, workshops, and economic benefits.

CU-Structural Soil®: A Comprehensive Guide: http://www.hort.cornell.edu/uhi/outreach/pdfs/CU-Structural%20Soil%20-%20A%20Comprehensive%20Guide.pdf, Nina Bassuk, Urban Horticulture Institute, Cornell University. Provides guidance on the application and design specifications of using structural soil.